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Thermodynamical aspects of modeling the mechanical response of granular materials *

Abstract

In many applications in rock physics, the material is treated as a continuum. By supplementing the related conservation laws with constitutive equations such as stress-strain relations, a well-posed problem can be formulated and solved. The stress-strain relations may be based on a combination of experimental data and a phenomenological or micromechanical model.

If the model is physically sound and its parameters have a physical meaning, it can serve to predict the stress response of the material to unmeasured deformations, predict the stress response of other materials, and perhaps predict other categories of the mechanical response such as failure, permeability and conductivity. However, it is essential that the model be consistent with all conservation laws and consistent with the second law of thermodynamics.

Specifically, some models of the mechanical response of granular materials proposed in literature, are based on intergranular contact force-displacement laws that violate the second law of thermodynamics by permitting energy generation at no cost. This diminishes the usefulness of these models as it invalidates their predictive capabilities.

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